

IONIC PROPULSION

Title: NUCLEAR ENERGY AND ROCKET PROPULSION

Author: A. V. Cleaver, F.R. Ae.S.

Source: The Aeroplane, June 5, 1953, p. 736 (reprint from "Atomic Scientists" News)

Excerpt from p. 738:

"Another possibility might become of practical interest at some future date, especially if efficient methods are ever developed for generating electrical power directly from nuclear energy, without intermediate thermal and mechanical devices (such as high exchangers, turbines, and generators). This would be the use of electrical potential, as generated from an atomic power source, to accelerate a beam of ions to form a propulsive jet. Such a device would in fact be a propulsive linear accelerator and has been the subject of preliminary theoretical studies under the name "Ion Rocket". Extremely high specific thrusts should be made possible, but the problem of disposal of waste energy would presumably be serious -- since the jet power varies as the exhaust velocity squared, while the thrust is merely a function of exhaust velocity."

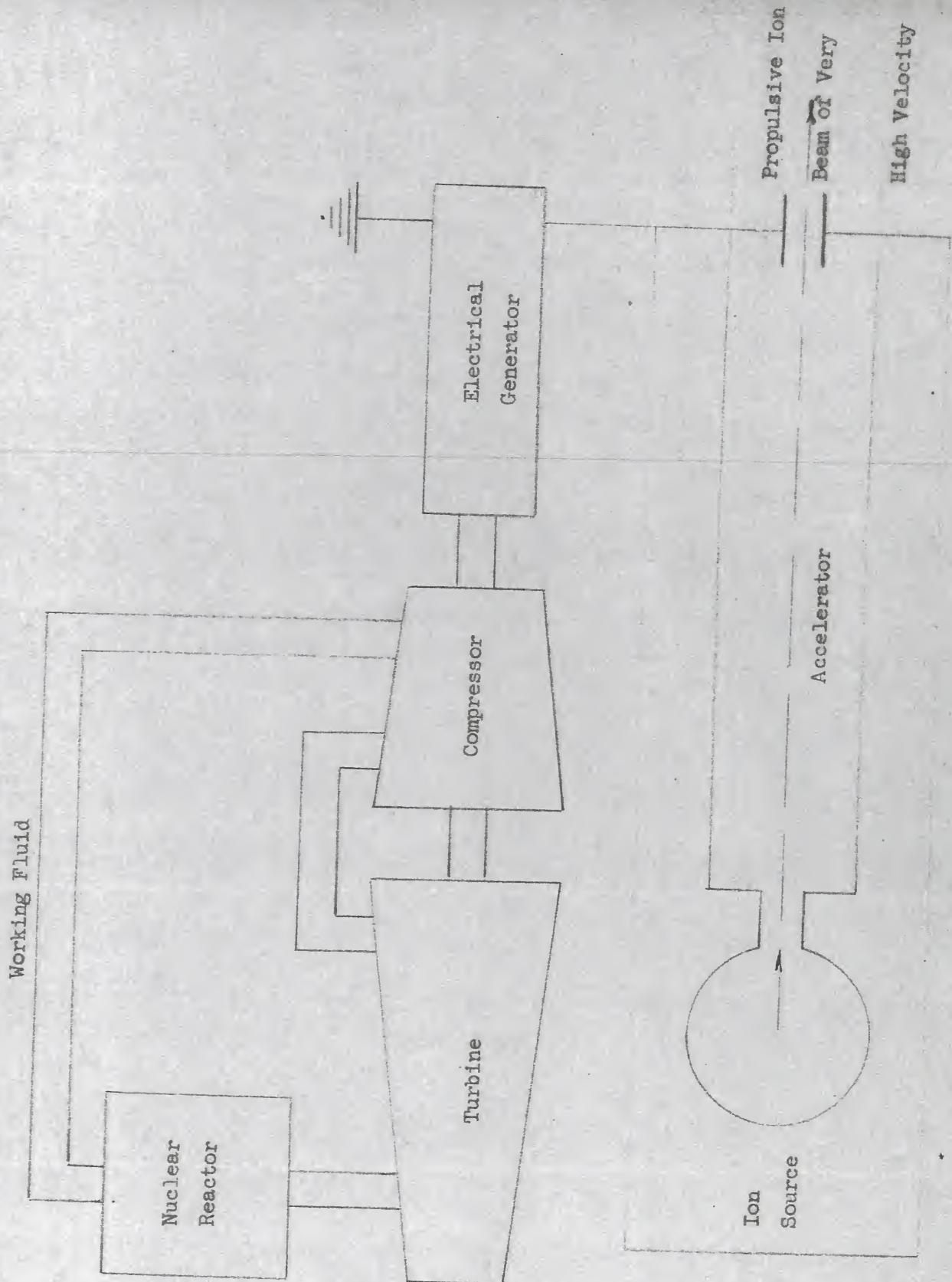


Figure 2. The "ion rocket" -- a possible method of applying nuclear energy to rocket propulsion where only very low thrusts are required. It might, for example, be used for gradual acceleration away from an initial stable circular orbit.

ANTI-GRAVITICSELECTROMAGNETIC PROPULSION

Title: THE PROBLEM OF ANNULING OR COUNTERACTING GRAVITY

Author: Herbert E. Salzer

Source: Rocketscience (J. of Detroit Rocket Society Inc.), vol. 6,
No. 1, March 1952, p. 8-13

DAC COMMENTS:

This is one of the most lucid articles discussing various schemes of counteracting gravity beyond the well-known fields of aeronautics and rocketry.

The author categorically debunks any alleged inventions implying annulment of gravity by shields or contraptions.

However, he leaves the question open as to whether the development of a unified or unitary field theory which would explain electricity, magnetism and gravity within a common framework might not show up a way for counteracting gravity by electrical devices. Most unified theories as far as they have thus far been outlined, though not yet convincingly established, are based on five- or six-dimensional geometry concepts of the world. The author himself proposes to seek a different solution, namely in the form of "tensor equations of the third order in terms of the metrical coefficients", expressing the "relativity of the third derivative of position".

Salzer dismisses the chances of exploiting the direct radiation pressure in a radiation gun type of engine because the momentum produced is so microscopical unless temperatures in the millions of degrees are tolerated. However, he does admit the possibility of developing an electromagnetic propulsion method based upon the interaction of self-emitted electromagnetic radiation with resonant or synchronized, partly shielded electrical oscillators aboard the vehicle.

NOTE: Herbert E. Salzer was born in Brooklyn, N.Y. in 1915 and received an M.A. in Mathematics in 1939 at Columbia. In 1952 he worked towards a doctorate. Since 1941 he has worked in Applied Mathematics for the U. S. Government.

W. B. Klemperer
12/8/54

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Alfred J. Zaehring, Editor

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The Problem of Annulling or Counter-Acting Gravity

by

Herbert E. Salzer

The terms "annulling or counter-acting gravity" usually refer to any means that would enable material objects in space to withstand the tendency to fall to the earth. Although a rocket during propulsion accomplishes precisely that effect, we do not consider such flight an annullment of gravity, because it is at the steady cost of material fuel which is part of the rocket. There the push on the rocket is due to the recoil from the impact of the material molecules of the vaporized fuel, in accordance with the law of conservation of momentum. But we seek an answer apart from rockets whose operation is mechanical in principle. Here the term "annulling" is distinguished from "counter-acting" in that the former would refer to a process making material objects on the earth weightless, whereas the latter would refer to any non-mechanical process of propelling such objects, even with their weight. Also, any process for non-mechanical propulsion of objects, even in outer space, could serve to counter-act gravity upon the earth.

Three different possibilities will be considered here in detail: (I) Annulment of gravity without cost in energy. (II) Annulment or counter-action with the expenditure of energy, employing some yet undiscovered relation between gravitational and electro-magnetic fields. (III) Counter-action by electro-magnetic propulsion employing some ingenious invention and based upon principles in the existing state of physical knowledge.

Before entering each line of thought, one should recall the existence of universal laws of physics, such as the conservation of energy-matter, the second law of thermodynamics which states the impossibility of heat flowing from a cooler body to a warmer body without the expenditure of work, and the conservation of momentum. There have been revisions of laws believed to be universal after new discoveries, one of the most celebrated examples being the revision of the nineteenth century laws of the separate conservation of matter and the conservation of energy into a single conservation law for energy-matter following the discoveries in radioactivity. Thus, nothing is really impossible if we allow for completely unknown and unexpected properties of matter. But any attempted solution to a problem which violates a universal law has no chance of success unless it embodies some hitherto undiscovered principle which has eluded the vigilance of thousands of research workers in countless experiments. The probability of finding a device for annulling gravity by contradicting any of the three above mentioned laws is extremely slight; but the possibility is present.

I

The first possibility, which is along the lines of producing a substance or invention that will be gravity repellent, has been dealt with by writers of fiction, most notably H.G. Wells, who has his moon-voyagers employ "cavorite", a mysterious weight-annulling substance. In the same category as "cavorite" would be any contraption which would annul gravity by the mere throw of a switch. Any annulment which is performed at either practically no cost of energy, or even which enables an object to be lifted to a certain height at the price of energy less than that required to raise the object to that height before annulment, would violate the

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law of conservation of energy. The reason is quite obvious; for by throwing the switch that annuls gravity, raising the object to a certain height, throwing the switch back again, and letting the object fall to its original position, one obtains a net gain in energy, or in other words a perpetual motion machine, which is about the physically most "impossible" thing in the world. The creation of such a perpetual motion machine would mean that the gravitational field, through some mysterious means, was a reservoir holding an infinite amount of energy that required only the proper key in order to siphon it out indefinitely- a very difficult notion to swallow. In fact it is misleading to compare this type of gravity annulment with insulation applied to the electric field in order to extract energy from it by the electric motor, because every electric field has only a finite amount of energy within it.

Also, any proposal for the possible condensing of gravitational energy from space considered as only a finite reservoir of gravitational power (a process that could not be carried out for an indefinite number of times) would not be contrary to the conservation of energy, but in all likelihood would be contrary to the second law of thermodynamics. The classic way of voiding the second law of thermodynamics is with the aid of Maxwell's demon, a hypothetical creature of molecular size who could sort out slow-moving from fast-moving molecules. Nobody has even shown that a Maxwell demon cannot be constructed. The condensation of gravitational power might possibly be effected with the aid of something analogous to a Maxwell demon.

Before leaving all considerations of gravity-annulment by finding hitherto unknown substances or contraptions, important light might be shed by Einstein's principle of equivalence which is one of the cornerstones of the theory of general relativity and gravitation. According to that principle a uniform gravitational field is not some mysterious type of attraction, but essentially identical with a field of mechanical acceleration. Then there is no possible notion of annulling gravity as a special type of force; but instead, the problem is equivalent to annulling acceleration. In other words, everything under the attraction of gravity might be considered in the same light as though it were in outer space, nowhere within the earth's attraction, and in a state of acceleration. The brilliant success of the Einstein theory of gravitation bears out the truth of the principle of equivalence; so that a search for a gravity-screening substance becomes elusive. For now, every particle of matter can be viewed not as being in a gravitational field, but merely as subject to the same acceleration. Then it is hard to conceive of how a combination of accelerated particles will have no acceleration at all, or even less acceleration. Thus, according to the principle of equivalence it would be futile to search for a means of annulling gravity considered as a special type of force; but instead one must look for a means of accelerating any given body other than by the mechanical rocket principle. This first approach might be summarized as one least likely of success in view of both the conservation of energy and Einstein's principle of equivalence. It is mentioned here as a possibility for the sake of scientific open-mindedness, but its probability is exceedingly small.

II

The second approach, annulment or counter-action without violating the conservation of energy, and by making use of some new knowledge about gravitational and electrical fields, has definitely more probability of success.

ess. However, it depends upon the development of a suitable unitary field theory, the problem of which has been taxing the best scientific brains for nearly fifty years. It is not possible to indicate specifically how gravity could be counter-acted with the aid of such a theory without knowing precisely the form that the theory would assume. The remarks here will be confined to a new suggestion for a unitary field theory, which is original with the writer, and which has not yet been tried by any of today's noted physicists. If this avenue leads to success, much more light will exist on how to counter-act a gravitational field.

All previous attempts at a unitary field theory either broadened the geometry of the world (Weyl, Eddington, and also Einstein), or added at least one extra dimension beyond the fourth (Kaluza and Klein). In other words, those developments all have been of a formal nature, and along more extensive lines. Yet there may be a unitary theory that is more intensive in nature, and which is physical rather than formal, and leading to some causal connection between electricity and gravitation.

If we review the progress of relativity we note that, to begin with, classical dynamics was based on the relativity of position, but the law of inertia gave reality to uniform motion, or rate of change of position. Even though position x was relative, yet dx/dt was real. In the next stage, relativity of uniform motion gave rise to special relativity, which still left acceleration, or rate of change of speed as a reality transcending the systems of reference, so that d^2x/dt^2 was still "real". Next, in general relativity the principle of infinitesimal equivalence implied the relativity of uniform acceleration by identifying d^2x/dt^2 at a point with a uniform gravitational field, and the resulting doctrine included gravitation. This still leaves a changing gravitational field, corresponding to a non-uniform acceleration, as an independent reality. Since classical theory, special relativity, and general relativity seem to be based upon the respective relativities of position and its successive derivatives with respect to time, the question naturally rises as to whether any physical significance might follow from the relativity of d^3x/dt^3 , representing a uniformly accelerated acceleration, or a changing gravitational field. Conceivably there might be electro-magnetic effects arising from rotation of massive bodies, or from very sudden changes in velocity. The former is in line with a recent theory of Blackett, who ascribes the earth's magnetic field entirely to its rotation; the latter was studied some twenty-five years ago by Tolman, who employed electron theory to explain definite electrical effects arising from bodies subject to sudden mechanical shock, or change of acceleration. But there was a certain small portion of the electrical effect that was not explained by electron theory, and Tolman's results might have a newer and deeper interpretation according to some theory based on the relativity of d^3x/dt^3 .

Just as gravitation requires second order derivatives in its formulation, electrical effects might very well require third order derivatives for their inclusion in a unified scheme instead of a wider geometry using only second order derivatives. In classical electro-magnetic theory it is wellknown that stationary electrical charges do not interact with stationary magnetic poles, but changing electric fields do have magnetic effects, while changing magnetic fields have electrical effects. The belief that all three types of fields are interrelated in some causal way, and the knowledge that stationary masses have no electro-magnetic effects leads one to hopefully expect changing gravitational or inertial fields to have electro-magnetic effects in accordance with some generalization of

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Maxwell's field equations connecting electrical and magnetic fields. Also, from epistemological considerations, we are much more aware of change than steady state, i.e., changing entities make the surrounding world more real in character, and even more so for changing change. This may account for the fact that in physics the more fundamental laws involve higher order derivatives. Now the fundamental laws of attraction entirely within the separate electrical, magnetic, and gravitational fields are no higher than second order differential equations, and the third order might suffice to unify all three types of fields. Further justification of the process of going to a higher order derivative than the second, follows from considering the role of differentiation and integration in formulating natural laws. While integration diversifies various entities, differentiation reduces the number of separate entities and unifies different things by establishing identities among their derivatives. Thus while there may be many different forms of energy, there are only three types of forces, and then further differentiation of those forces should be expected to unite them.

The desired equations might be similar to the field equations of general relativity; only instead of being second order tensor equations in terms of the metrical coefficients, they would be of the third order, and that extra constant of integration would have some fundamental electrical significance, such as the amount of charge. Further discussion of the possible third order equations is contained in the writer's monograph, "The Problem of the Unitary Field Theory" (not yet published).

If this extension of general relativity to third order differential equations is valid, besides relativity of motion we should have relativity of substance, where substance refers to matter or electricity. Since the laws of attraction between poles, charges, or masses are similar, and none of those three types of static fields affects another different type, one should expect a suitable extension of relativity theory to single out none of those three fields as being more real than the others. Just as special relativity did not single out any privileged moving frame of reference, a suitable third order theory would place mass, electric charge, and magnetic pole each by itself upon the same plane of absolute unreality, and reality or physical equivalence would be asserted only between changes of those entities, leading to complete relativity of electrical, magnetic, and gravitational fields. In further support of this notion, we recall that: (1) Maxwell's equations are already third order equations, since they involve derivatives of the forces. (2) In 1929 Einstein had a theory and it was recast by Levi-Civita, where certain geometric quantities (based on Ricci coefficients of rotation, which involved second derivatives of metric coefficients) were identified with components of electro-magnetic force; but neither of these men followed up the third order differential equation resulting from that identification. (3) The sameness of the ratio of the charge to the mass of the electron, namely e/m , for every electron, is no more to be expected than the equality of gravitational and inertial mass. The latter condition follows from Einstein's principle of equivalence involving second derivatives; the former condition would follow from an equation in third derivatives which would imply that a changing (precise manner of change not yet determined) gravitational force is equivalent to a changing electro-magnetic force. There we see how we must get, after integration, the same m associated with every e , because the ultimately underlying physical world substance has both mechanical and electrical aspects.

In conclusion regarding the second possibility, just as Nature seems

to always conceal the fact as to whether we are "really moving", there might be a third order theory whose cornerstone is that Nature forever conceals the fact as to whether the physical world is essentially electrical or mechanical. Such a theory would lead to a physically concrete picture of changing gravitational fields in terms of changing electromagnetic fields. This, in turn, may tell us how to annul gravity or acceleration in a manner not contradictory to both the conservation of energy and Einstein's principle of equivalence. The annulment would be in the same sense that a positively charged body can remain suspended over a positively charged plate, - indefinitely and without the expenditure of work apart from that needed to move the object to its position.

III

The third proposal is to attempt to apply Yankee ingenuity to existing knowledge, without contradicting any universal laws, in order to design an electro-magnetic repulsion motor. According to Maxwell's theory, electromagnetic radiation exerts a direct mechanical repulsion upon the body emitting it (verified experimentally some fifty years ago), but it's far too small to be used in an electro-magnetic rocket. Only when the temperature runs into hundreds of millions of degrees, does radiation exert mechanical forces large enough to propel a rocket; but at such temperatures all known materials would have evaporated. Hence the direct pressure of radiation must be ruled out. For similar reasons we must reject atomic energy for an ordinary mechanical rocket utilizing molecular kicks for repulsion, because of the terrific temperatures involved and the insuperable difficulty of insulation. But we may envision the counter-action of gravity by an electro-magnetic rocket which would not require tremendous amounts of fuel (which in turn requires extra fuel to lift it, and so on) and which would be in comparison with ordinary rockets: (a) more efficient, (b) more compact, (c) more controllable, (d) more clean-cut, and (e) safer for passengers. Here we must expect to pay by a continual expenditure of energy in the form of radiation, even if we are only remaining motionless in space. For just as we cannot hold ourselves in mid-space by our bootstraps, there is no reason to hope for "electro-magnetic bootstraps" to perform the same lifting function. Moreover (and this may be a more ticklish difficulty) we must obey the law of conservation of momentum, so that the gain in momentum of the moving body is equal to the momentum of the electro-magnetic radiation that is emitted. Although the density of electro-magnetic momentum is very slight, there would be many cubic miles of radiation to allow for a total momentum equivalent to the momentum of the moving body.

To see what principle might be used in an electro-magnetic rocket, let us recall how a rowboat goes forward- because its oars push upon the surrounding medium of water which, to begin with, is something not connected with the boat. Now in empty space, or in the "ether", there is nothing that offhand seems capable of playing the role of the oar by pushing on the "ether", since we are discounting the negligible direct mechanical pressure of electro-magnetic radiation. But suppose that an object is immersed in space filled with electro-magnetic radiation; even if the radiation comes from the object itself, as soon as it leaves the surface of the object, it has an independent existence in space. The question arises as to whether an object can emit electro-magnetic waves, and at the same time have other electrical effects produced independently upon a portion of its surface, so that those surface effects may interact with the electro-magnetic waves and give rise to repulsion. Of course, that

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repulsion would be paid for by energy additional to that producing the electro-magnetic waves. Just as a heavy frictionless block upon a perfectly smooth and level board can move from end to end of that board by tilting the board almost infinitesimally, there could be many ways of quickly removing a large amount of charge from a surface, without too much energy, and bringing it back again. Suppose that this charging and discharging were done in synchronization with an electro-magnetic wave that is emitted from another part of the body, in such a way that the negative charge appeared on the plate for a fraction of a period of the electro-magnetic wave, just during that instant when the largest negative part of the electrical component of the radiation was over the plate. Naturally, a charge remaining for a complete oscillation will receive no net push or pull. Conceivably there would be a repulsion of the plate (no bootstraps here, because the wave is disconnected from the object). It is also conceivable that any such contrivance may generate effects that tend to void that repulsion (maybe the acceleration of the charged plate would cause an interaction with the electro-magnetic waves, to produce a net effect of no acceleration). All this would have to be investigated, since an electro-magnetic rocket may very well be impossible. At this stage it can only be said that there is no offhand impossibility. There may be even more than one way of expending energy into the ether, and obtaining a succession of repulsions to maintain motion. For example, even though electro-magnetic momentum is very small, we might devise an apparatus that will emit radiation whose rate of change of momentum is extremely large, which would result in a large repulsive force.

Still another approach may be in keeping with the idea that near the surface of an oscillator the effects are more inductive, whereas a few wave lengths away the effects are more radiative. The propulsive force might be obtained from synchronized oscillators (one of them suitably shielded upon one side to avoid symmetry and no net repulsion) so that the inductive effect on one would react with the electro-magnetic waves produced by the other.

In a more complicated vein, just as in Bernoulli's theorem applied to the air stream over and under an airplane wing shaped in a certain way, predicts the lifting effect, perhaps there is an electro-magnetic analogue, such as an "electrical stream" over and under a wing, to produce a lift. Again, there may be something analogous to an electro-magnetic helicopter.

In every case where an electro-magnetic rocket may be devised, there is next to no loss in weight, and therefore (unlike ordinary rockets) no extra weight to carry in fuel. Furthermore, slow and controlled atomic energy, in very compact form, might be used to generate the electrical energy necessary to carry out the scheme that works. In fact, if successful, such an electro-magnetic rocket would be the most practical and likely method of counter-acting gravity for the nearer future, and it would have the five advantages (a)-(e) mentioned above when compared with ordinary rockets.

ABOUT THE AUTHOR:

Herbert E. Salzer was born in Brooklyn, New York on April 23, 1915, graduating from Columbia College in 1933 and receiving his M.A. in mathematics in 1939. He is now working on his doctorate. From March, 1941 to the present time he has worked in the field of applied mathematics for the government.

